

NOTE ON SOME OF THE MORE RECENT CHANGES IN LEVEL OF THE COAST OF BRITISH COLUM- BIA AND ADJACENT REGIONS.

By GEORGE M. DAWSON, ASSOC. R. S. M., F. G. S.

Of the Geological Survey of Canada.

The elevation of the Cascade or Coast Range of British Columbia, and the parallel range of Vancouver Island, must have taken place to a great extent, though probably not entirely, in post-cretaceous times. On the upturned and denuded edges of Cretaceous rocks, in the interior of British Columbia, rest nearly horizontal beds, which appear to be of Miocene age, and which pass upward into the great sheets of volcanic material, with which the whole interior plateau must at one time have been covered. The sedimentary Miocene beds seem to have been formed in fresh-water lakes, produced perhaps by interruption of the drainage by mountain elevation, which there is evidence to show, may have continued to some small extent even in post-miocene times. The country cannot have been so low at this period as to admit the sea to the interior plateau, but appears to have been depressed to a small extent, as marine tertiary beds, probably of this age, are found along the coast above the present sea-line. No Pliocene deposits have yet been recognised, and it was probably during this period, with the land standing at least 900 feet higher than at present, that the deep river valleys or canons now forming the remarkable system of fjords by which the coast is dissected, were cut out. These fjords are very generally in their sheltered upper reaches over 100 fathoms in depth, often over 150 fathoms, and probably in many cases over 200; though in most of them the actual depth has only been ascertained in a few places. When they open on the broader waterways, where the strong tides of the Pacific coast run with greater power, they are found to be silted up, and blocked with bars and banks; the water being generally shoalest where the water stretches are most extensive. This is especially noticeable on the west coast of Vancouver Island. The ice which can be shown to have filled these fjords during the glacial period, must have deepened them and altered their forms to some extent, but probably in a degree quite inconsiderable when compared with their pre-glacial excavation.

During the glacial period the country was submerged, but into the history of this epoch, and evidence of the very great extent of this submergence, I do not propose here to enter. In my Report on the Geology and Resources of the 49th Parallel, I have given the grounds which lead me to believe in a submergence at this time of at least 4,400 feet, on the eastern slopes of the Rocky Mountains. In the central portions of British Columbia, ice-bearing water must have stood at a level of 5,270 feet. I do not wish to insist that this must necessarily have been the sea, though that appears best to account for the facts.

Mr. George Gibbs states,* that the passages and inlets of Puget Sound, in the northern part of Washington Territory, are excavated in many places in drift deposits, which appear not only to form their present banks, but to underlie their beds. If this be correct, there is here pretty good evidence of a post-glacial elevation of the land to a height somewhat greater than the present; for the long river-like inlets, referred to, bear all the appearance of having been *formed* by river erosion and afterwards filled and widened only by the action of the sea and tidal currents.

No elevation or depression of the coast of the southern part of Vancouver Island is known to have taken place very recently, but the aspect of the shore is that of one gradually subsiding, and I had arrived at this conclusion from its examination before meeting with the statements of others, shortly to be mentioned. Near Victoria the low rocky substructure of the country, is partly enveloped in a somewhat irregular terrace, of which the average height may be about 40 feet. It is composed of clays, more or less arenaceous, holding boulders, and in some places also marine shells indicating pretty deep water. Cliffs of this clay are being rapidly wasted, along some parts of the shore, where the water may be seen during the higher winter tides actually removing this material from the polished and glaciated rock surfaces, wave by wave. The rocks about high water nearly all preserve very perfectly their glacial markings, which lower down are not so distinct; but in many places even where they receive the full force of the sea at every tide, they are much better preserved than would be the case if they had been for an indefinite number of years exposed to its action. In shallow bays, where the sloping pebbly beach is bordered land-

ward by a low perpendicular bank of the clays, I have seen the water during the high tides of winter actually above the stony beach, and beating against the clay, with which it was rendered turbid for some distance from the shore. In certain localities the old Indian shell heaps or kitchen-middens, which are abundant on this coast, are exposed in section by the sea in similar low banks, and the lower layers of some of these have been observed to be nearly a foot, in some places, below the high tide mark; showing I think that subsidence to a small extent has taken place since they were formed. The Indians would scarcely choose for camping a place liable to overflow, and if the shells were merely thrown there, they would have been scattered from time to time by the high tides, and would not have accumulated in heaps six to eight feet thick and very wide.

The land was probably at a somewhat lower level, when first inhabited by the Indians, for the upper layers of the pale clayey drift above referred to, merge in some places quite gradually into a darker coloured and more earthy material, from six inches to two feet in thickness, which forms the soil of the cultivable tracts. This follows the slope of the surface and was probably deposited by the retreating waters, when for a time each level was an oozy sea margin, like that found at the heads of some of the present sheltered bays, in process of transition to land, and including in its mass much decomposed vegetable matter. In the very lowest layers of this darker material, I have noticed in one or two places, at heights of five to ten feet above the present beach line, burnt stones like those used by the Indians in cooking, and other signs of their presence.

There is no evidence to show that any movement greater in amount than a few feet, has taken place for a long time. The growth of very large trees near the present high water mark in the sheltered inlets, would seem to negative any great elevation. It would also seem probable that the movement of depression indicated in the extracts from Vancouver and Cooper, may have taken place rapidly, perhaps in connection with some of the small earthquake shocks by which this coast is visited from time to time. At the heads of all the inlets or fjords of the coast, a stretch of low, flat, and often marshy ground, shoaling very gradually seaward, and then in quarter or half a mile beyond the shore plunging steeply down into deep water, surrounds the mouths of the entering rivers. The position of these flats with

regard to the sea level is very much what we might expect from the action of the rivers and tides still in progress, though in some places they are probably a little higher than the present circumstances will explain. Had the coast permanently changed its elevation by as much as fifty feet in either direction, during many centuries, the aspect of affairs would no doubt be quite different.

Vancouver gives in the course of his relation, some singularly interesting statements bearing on the sinking of the coast. Of Port Chalmers, in Prince William's Sound (lat. $60^{\circ} 16'$) under date June, 1794, he writes* :—

“ The shores are in general low, and as has already been observed, very swampy in many places, on which the sea appears to be making more rapid encroachments than I ever before saw or heard of. Many trees had been cut down since these regions were first visited by Europeans ; this was evident from the visible effects of the axe and saw, which we concluded had been produced whilst Messrs. Portlock and Dixon were here, seven years before our arrival, as the stumps of the trees were still remaining on the earth where they had originally grown, but were now many feet below the high water mark even of neap tides. A narrow low projecting point of land behind which we rode, had not long since afforded support to some of the largest pine trees in the neighbourhood, but it was now overflowed by every tide, and excepting two of the trees which still put forth a few leaves, the whole were reduced to naked, dead white stumps, by the encroachment of the sea water to the roots ; and some stumps of trees, with their roots still fast in the ground, were also found in no very advanced stage of decay nearly as low down as the low water of spring tides.”

The place here spoken of by Vancouver, has it seems lately been called *Sinking Point* by the U. S. Coast Survey. It is mentioned under this name by Mr. Davidson in the *Alaska Coast Pilot* (1869) who however gives no description of its present appearance. Mr. Davidson suggests that the trees observed by Vancouver may have been felled by the Russians before Portlock and Dixon's visit, but as these commanders stayed here ten days, careening and overhauling their vessels,

* A Voyage of Discovery to the North Pacific Ocean and Round the World. London 1801. Vol. V., p. 335.

and yet make no mention of signs of previous visitors in their narrative,* it is probable that Vancouver was correct in his supposition. Mr. Dail, in the *Coast Pilot* (p. 193) shows pretty conclusively that the peninsular part of Alaska, west of the 150th meridian, is being, or has lately been elevated. Winrows of drift wood in various stages of decay are found above the highest levels ever now attained by the sea, and in the crevices of rocks, fifteen feet above high water, portions of the shelly covering of a species of barnacle are found *in situ*. He also refers to Sinking Point, but inclines to the belief that the subsidence there shown is merely local, which, in view of the other facts here cited it can scarcely be.

In detailing the observations of his sailing master, Mr. Whidbey, on another part of the coast, near Admiralty Island† (near lat. 58°,) more than four hundred miles eastward from Port Chalmers, Vancouver says:—

“He also states, that in his last excursions several places were seen, where the ocean was evidently encroaching very rapidly on the land, and that the low borders extending from the base of the mountains to the sea side, had, at no very remote period of time, produced tall and stately timber; as many of their dead trunks were found standing erect, and still rooted fast in the ground, in different stages of decay; those being the most perfect that had been the least subject to the influence of the salt water, by which they were surrounded at every flood tide: Such had been the encroachment of the ocean on these shores, that the shorter stumps in some instances at low water mark, were even with or below the surface of the sea. The same appearance had been noted before in Port Chalmers, and on this occasion Mr. Whidbey quotes other instances of similar encroachments, not only in Prince William's Sound, but also in Cook's Inlet, where he observed similar effects on the shores.”

Dr. J. G. Cooper, in the *Natural History of Washington Territory*, makes the following note:—“On the tide meadows about Shoal Water Bay, dead trees of this species (*Thuja Gigantea*) only, are standing, sometimes in groves, whose age must be immense though impossible to tell accurately. They

* *A Voyage Round the World, and to the North-West Coast of America*. London, 1789.

† *Op. cit.* Vol. IV., p. 53.

evidently lived and grew when the surface was above high-water level, groves of this and other species still flourishing down to the very edge of inundation. But a gradual slow sinking of the land (which seems in places to be still progressing, and is perhaps caused by the undermining of quicksands) has caused the overflow of the tides, and thus killed the forests, of which the only remains now left are these cedars. This wood is perfectly sound, and so well seasoned as to be the very best of its kind. Continued and careful examination of such trees may afford important information as to the changes of level in these shores. That these have been numerous and great is further shown by alternating beds of marine shells, and of logs and stumps, often in their natural position, which form the cliffs above the bay to the height of 200 feet. But while these remains show that the changes took place in the latest periods of the Miocene tertiary epoch (?) there is no evidence in the gigantic forests still living on these cliffs, that any *sudden* or *violent* change has occurred since they began to grow—a period estimable rather by thousands than by hundreds of years."

The testimony of a small change toward depression within the last ninety or one hundred years appears concurrent.

The various Indian tribes of the coast and interior, like all peoples, have their stories, more or less unreal and grotesque, of deluges, or *the deluge*. The Okanagans, for instance, who inhabit the southern part of the interior, in a long rambling story relating their first arrival in the country which they now inhabit, are said to state* that, "after paddling day and night for many suns, they came to certain islands, whence steering through them, they came at last to where the mainland was, however much smaller than in these days *having grown much since*."

That they had been made familiar by tradition or experience with change of the sea level is apparent from the statement of Mr. Gibbs,† that on occasion of a slight earthquake shock, the Indians of Whidbey Island, in the Strait of Georgia, in reply to an enquiry if they knew what it was, said that the "earth was rising."

The most remarkable Indian tradition, however, quite equal in its way and in the circumstantiality of its details, to the

* Bancroft, Native Races of the Pacific States, Vol. III., p. 154.

† Loc. cit. p. 359.

Chaldean account of the deluge lately unearthed, has been found by Mr. J. G. Swan among the Makah Indians of Cape Flattery, the southern point at the entrance to Juan de Fuca's Strait. This, though no doubt much exaggerated, probably embalms the memory of some real event, either of the nature of an earthquake wave, or depression and reelevation due to the not yet wholly extinct volcanic forces of the coast.

Mr. Swan writes * :—"A long time ago," said my informant, "but not at a very remote period, the water of the Pacific flowed through what is now the swamp and prairie between Wüach Village and Neeah Bay, making an island of Cape Flattery. The water suddenly receded, leaving Neeah Bay perfectly dry. It was four days reaching its lowest ebb, and then rose again without any waves or breakers, till it had submerged the Cape, and in fact the whole country except the tops of the mountains at Clioquot. The water on its rise became very warm, and as it came up to the houses, those who had canoes put their effects into them, and floated off with the current, which set very strongly to the north. Some drifted one way some another; and when the waters assumed their accustomed level, a portion of the tribe found themselves beyond Nootka, where their descendants now reside, and are known by the same name as the Makahs in Classet (Cape Flattery) or Kwenaitchechat. Many canoes came down in the trees and were destroyed, and numerous lives were lost. The water was four days regaining its accustomed level." The same story is preserved by the Kwillyutes, who say that part of their tribe floated to the region near Port Townsend, where their descendants are known as the Chemakum Indians. The latter again claim to have originally sprung from the Kwillyutes. Mr Swan adds :—"There is no doubt in my mind of the truth of this tradition. The Wüach prairie shows conclusively that the waters of the Pacific once flowed through it; and on cutting through the turf at any place between Neeah Bay and Wüach, the whole substratum is proved to be pure beach sand. In some places the turf is not over a foot thick; at others the alluvial deposit is two or three feet."

Leaving, however, the realms of tradition, the conclusions provisionally arrived at, as to the former levels of the coast, may thus be summed up,—

* Indians of Cape Flattery, 1869, p. 57.

Miocene Period.—Immediately succeeding considerable mountain upheaval, and closed by basalt flows of the interior. Coast at least during part of this period somewhat lower than at present.

Pliocene Period.—Land elevated at least about 900 feet above the present sea line for part or the whole of this period.

Glacial Period.—At one or more epochs during this period land much depressed; at one time probably over 5,000 feet.

The country considerably below the present level when the glacier of the Strait of Georgia finally retreated from the southeastern part of Vancouver Island.

Post Glacial and Modern.—Reelevation to height probably 200 or 300 feet greater than at present, followed by depression to near the present level, with probably many changes of small amount, and perhaps one or more rather important movements as indicated by the Indian stories. Lastly, somewhat rapid depression of perhaps ten or fifteen feet during the latter part of last century, a movement which may still be slowly going on.

Subsequent examination of this part of the Pacific coast may enable us to add many details to this necessarily somewhat imperfect scheme.

